Results on jets in p-p and Pb-Pb data with ALICE

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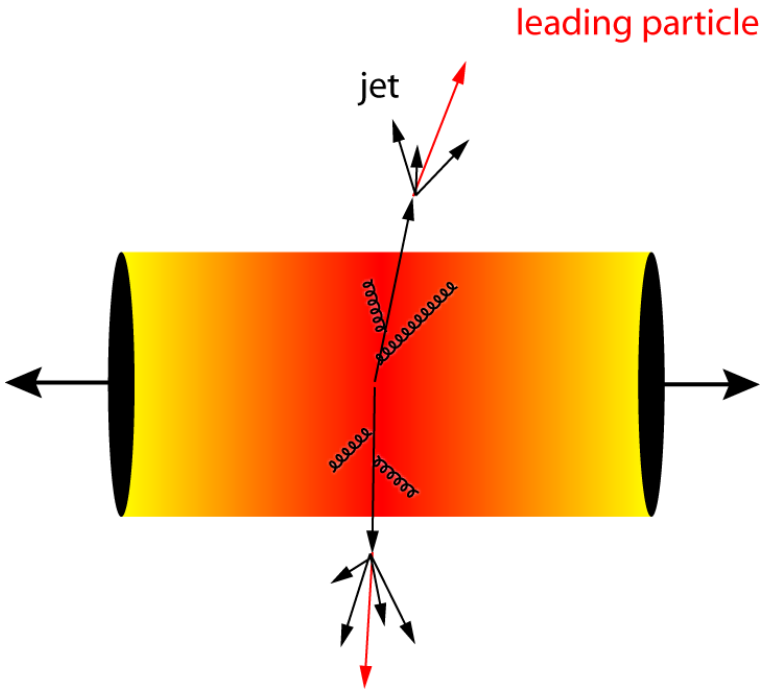
25th Indian-Summer School "Understanding Hot & Dense QCD Matter"

Outline

- Motivation
- Measurement of jets with the ALICE detector
- Results in p-p collisions @ $\sqrt{s} = 7$ TeV
- Results in p-p collisions @ $\sqrt{s} = 2.76$ TeV
- Results in Pb-Pb collisions @ $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV
- Summary and outlook

Motivation

- heavy-ion collisions
  - probing phase diagram of hadronic matter
  - Quark-Gluon Plasma (QGP)
- jets
  - origin in hard scattering at early stage of collision
  - in p-p: test of pQCD, models, MC generators, reference for jets in Pb-Pb
  - in Pb-Pb: suffer modifications by interactions with medium (energy, shape,...) $\rightarrow$ "jet quenching"



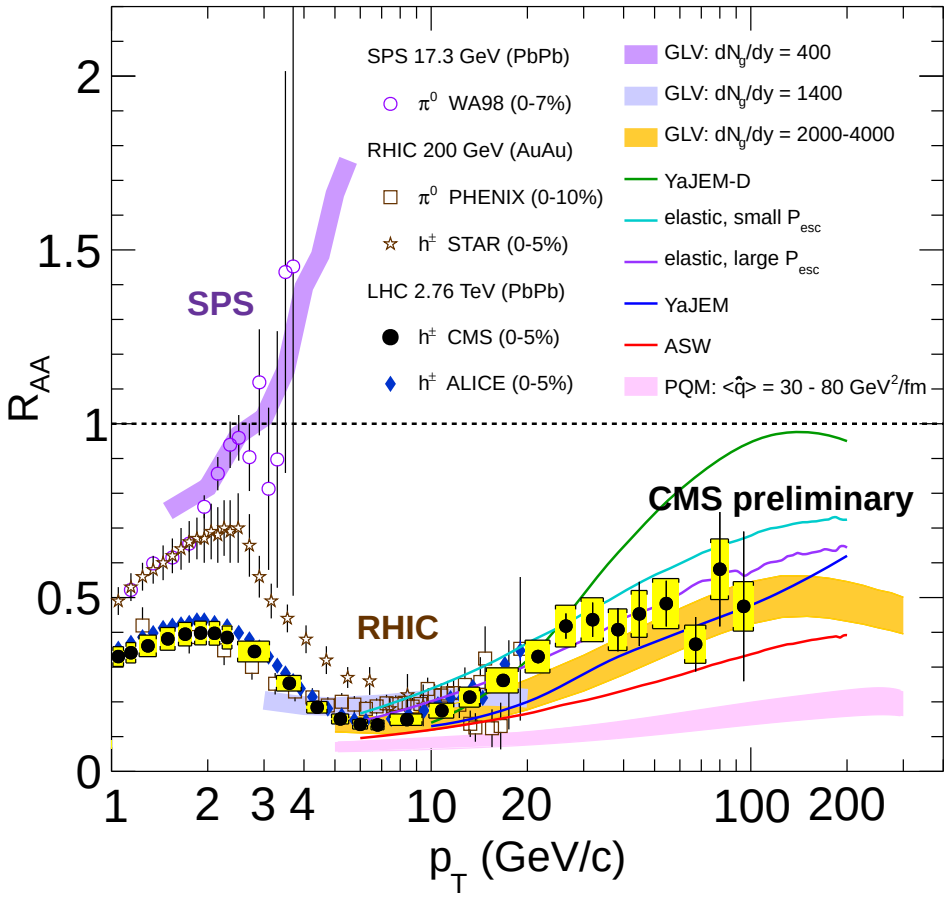
Motivation

Medium-induced suppression of hadron production in heavy-ion collisions

expressed by the spectrum in A-A collisions scaled to one binary nucleon collision, compared to the spectrum in p-p collisions

$$R_{AA} = \frac{1}{N_{coll}} \frac{d^2N^{AA}/dp_T d\eta}{d^2N^{pp}/dp_T d\eta}$$

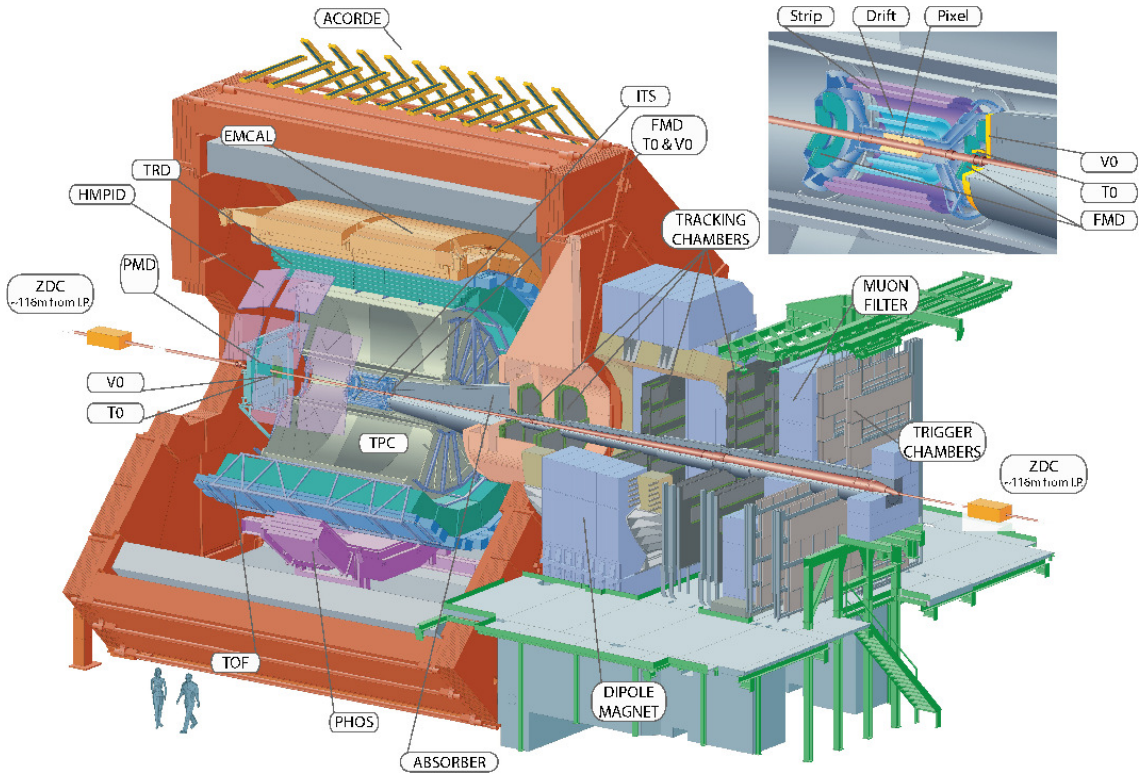
- $R_{AA} < 1$ in large range of p_T
- $R_{AA}^{LHC} < R_{AA}^{RHIC}$
- excludes some models



CMS-PAS-HIN-10-005

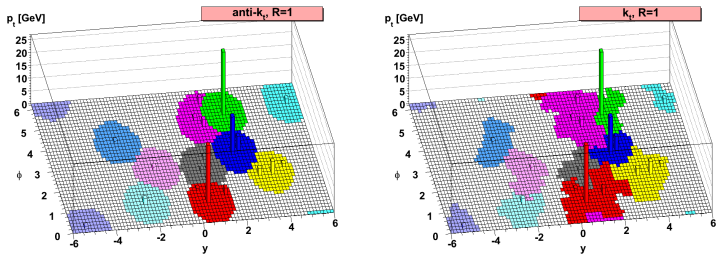
Measurement of jets with the ALICE detector

- Inner Tracking System (ITS): silicon pixels, drift and strips, $|\eta| < 0.9$
- Time Projection Chamber (TPC): gas detector, $|\eta| < 0.9$
- Electromagnetic sampling calorimeter (EMCal): Pb + scintillator, $|\eta| < 0.7$, $1.4 < \phi < \pi$

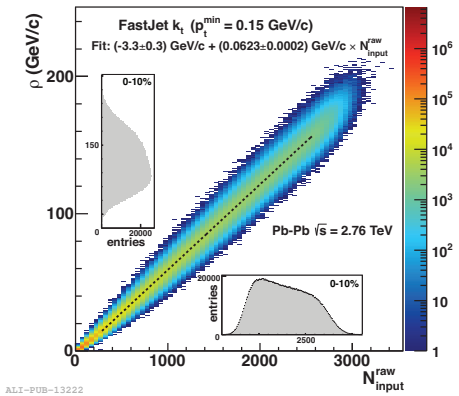


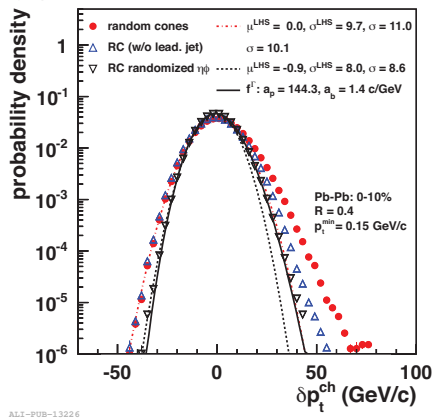
Jet reconstruction & background treatment

- Jet reconstruction
  - momenta of charged tracks from ITS & TPC, $p_{\mathrm{T}} > 150\,\mathrm{MeV}/c$
  - clusters from EMCal, $E_{\mathrm{T}} \geq 300\,\mathrm{MeV}$, correction for charged-particle contamination
  - signal jets found with anti-k_{t} algorithm, $(R = 0.2, 0.3, \ldots)$
  - charged/full-jet reconstruction
- Correction for p_{T} from background in Pb-Pb
  - $p_{\mathrm{T,jet}} = p_{\mathrm{T,jet}}^{\mathrm{rec}} - \rho A_{\mathrm{jet}} \pm \sigma_{\rho}\sqrt{A_{\mathrm{jet}}}$
  - average density ρ from k_{t} jets, determined and subtracted event-by-event
  - correction for non-uniformity (σ_{ρ}) via unfolding (δp_{T})



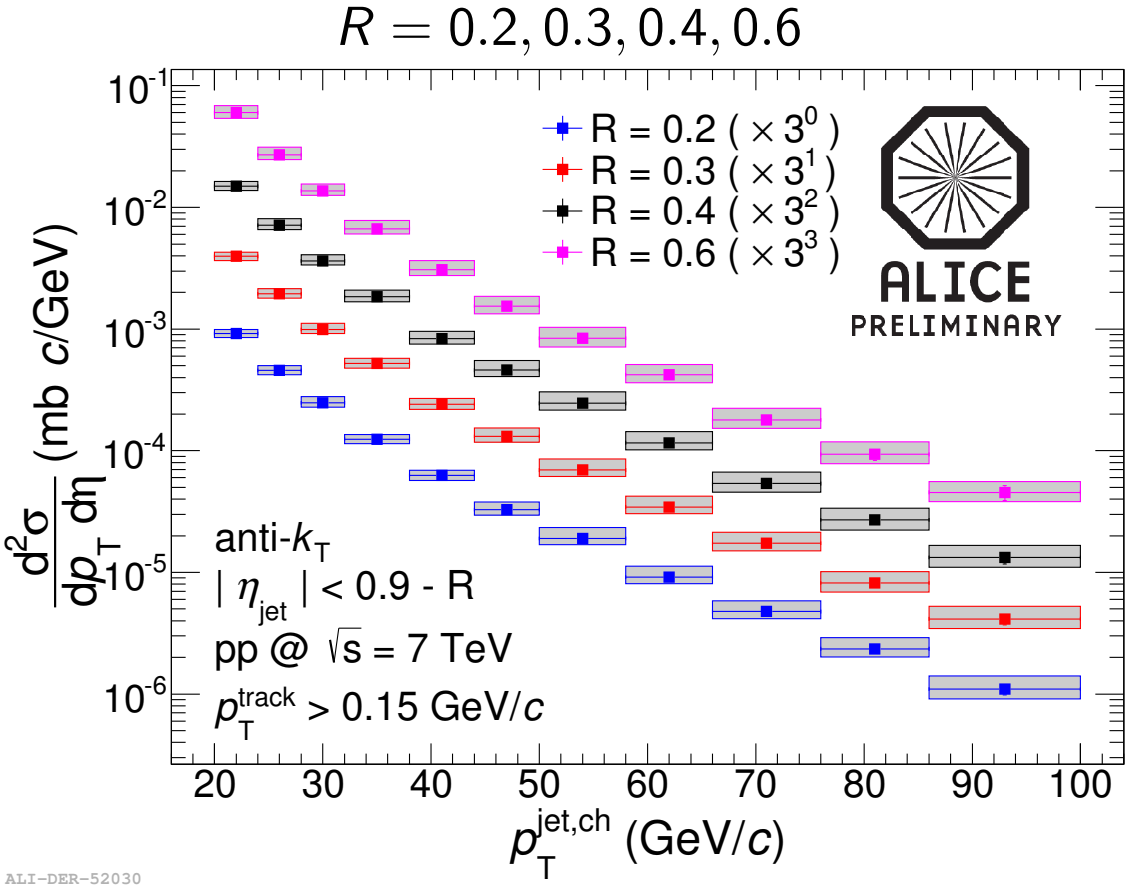
M. Cacciari, G. P. Salam and G. Soyez, Eur. Phys. J. C **72** (2012) 1896





ALICE, JHEP 1203 (2012) 053

Fully corrected inclusive charged-jet cross section in p-p collisions @ $\sqrt{s} = 7$ TeV



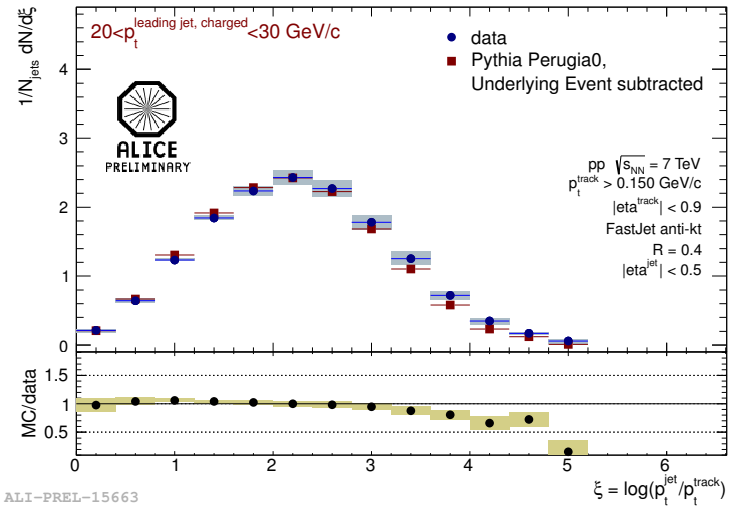
important reference for other jet measurements and for comparison with other experiments and calculations

Fragmentation function of charged particles in charged jets in p-p collisions @ $\sqrt{s} = 7$ TeV

$R = 0.4$

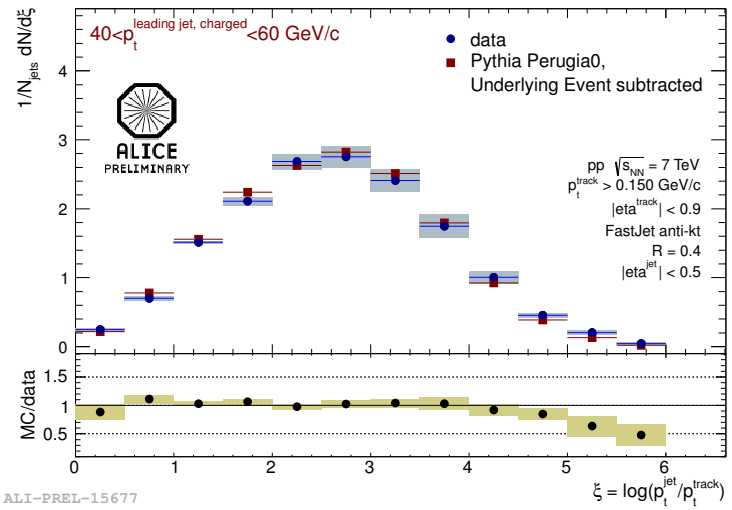
$\xi = \ln(p_{\mathrm{T}}^{\mathrm{jet}} / p_{\mathrm{T}}^{\mathrm{track}})$

$20\ \mathrm{GeV}/c < p_{\mathrm{T}}^{\mathrm{jet}} < 30\ \mathrm{GeV}/c$

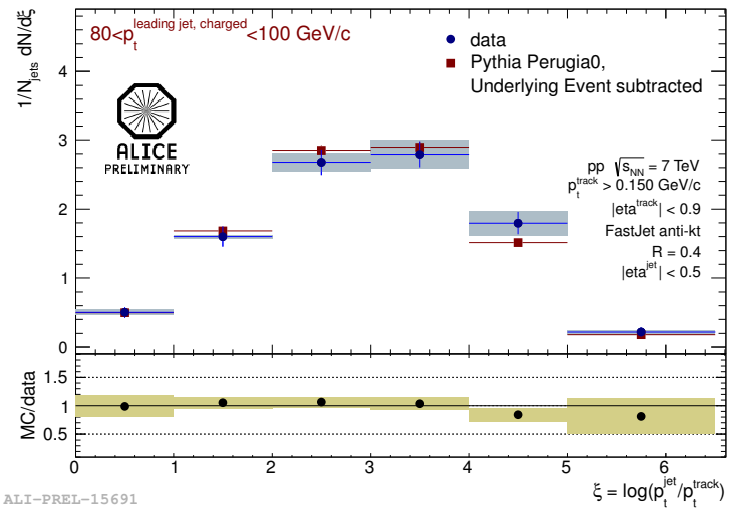


"hump-backed plateau",
ξ of maximum increases with $p_{\mathrm{T}}^{\mathrm{jet}}$,
good agreement with Pythia in large range of $p_{\mathrm{T}}^{\mathrm{jet}}$

$40\ \mathrm{GeV}/c < p_{\mathrm{T}}^{\mathrm{jet}} < 60\ \mathrm{GeV}/c$



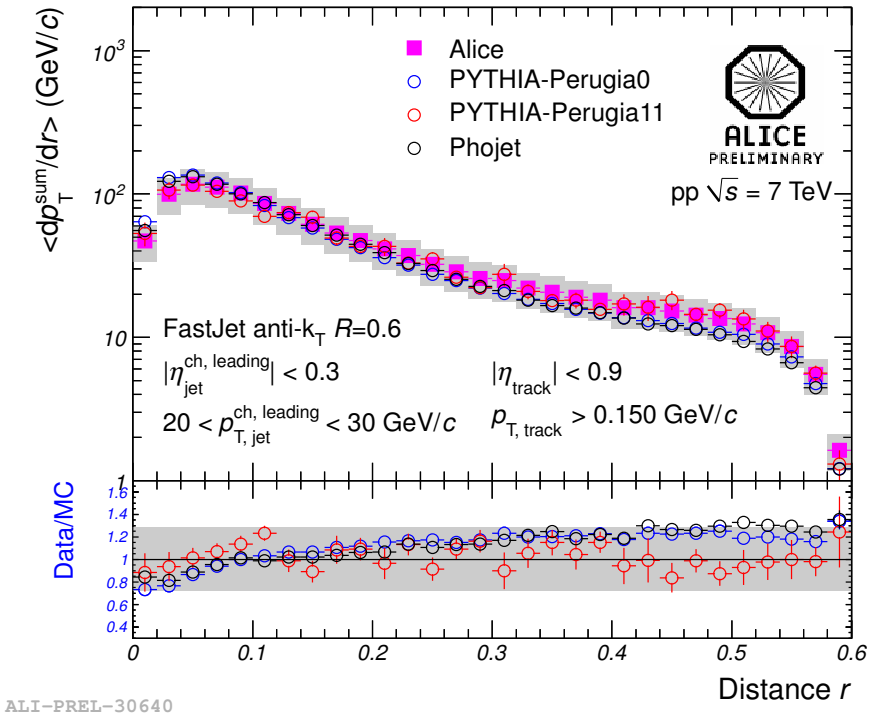
$80\ \mathrm{GeV}/c < p_{\mathrm{T}}^{\mathrm{jet}} < 100\ \mathrm{GeV}/c$



Radial distribution of p_{T} in charged jets in p-p collisions @ $\sqrt{s} = 7$ TeV

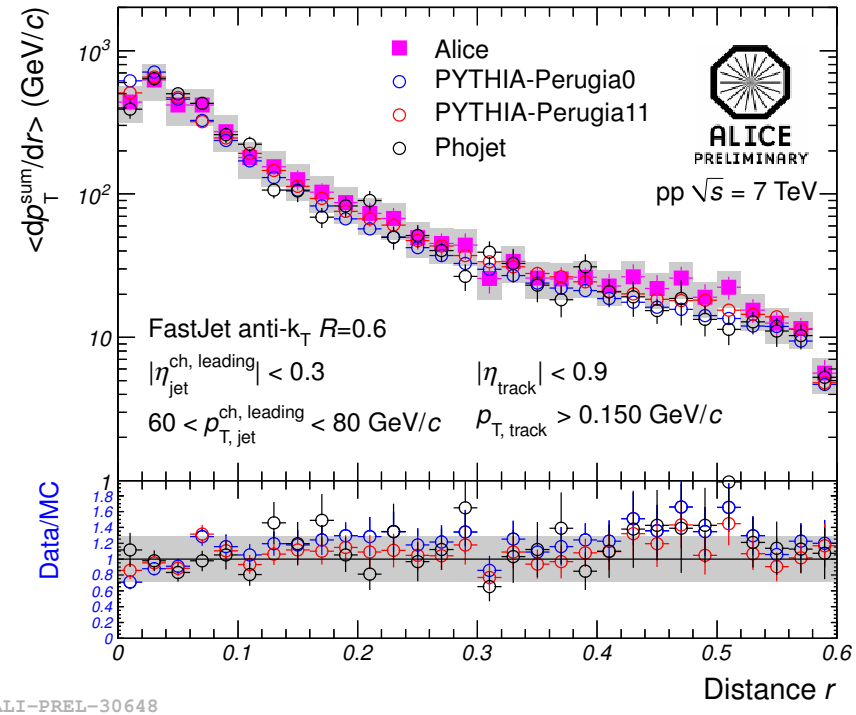
$R = 0.6$

$20\ \mathrm{GeV}/c < p_{\mathrm{T}}^{\mathrm{jet}} < 30\ \mathrm{GeV}/c$



ALI-PREL-30640

$60\ \mathrm{GeV}/c < p_{\mathrm{T}}^{\mathrm{jet}} < 80\ \mathrm{GeV}/c$

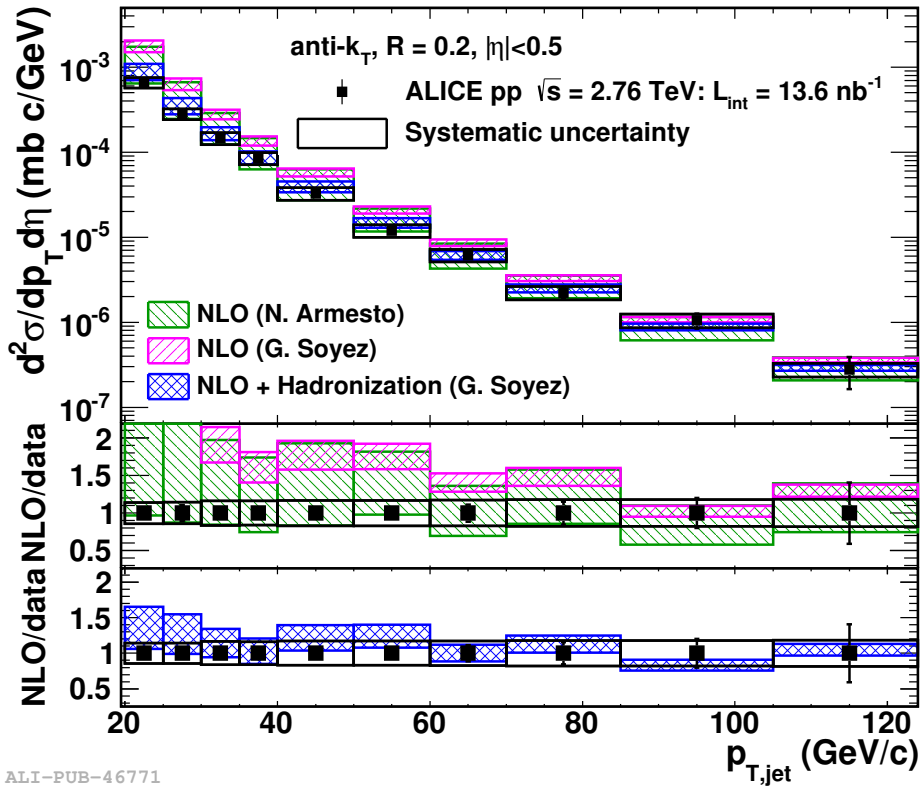


ALI-PREL-30648

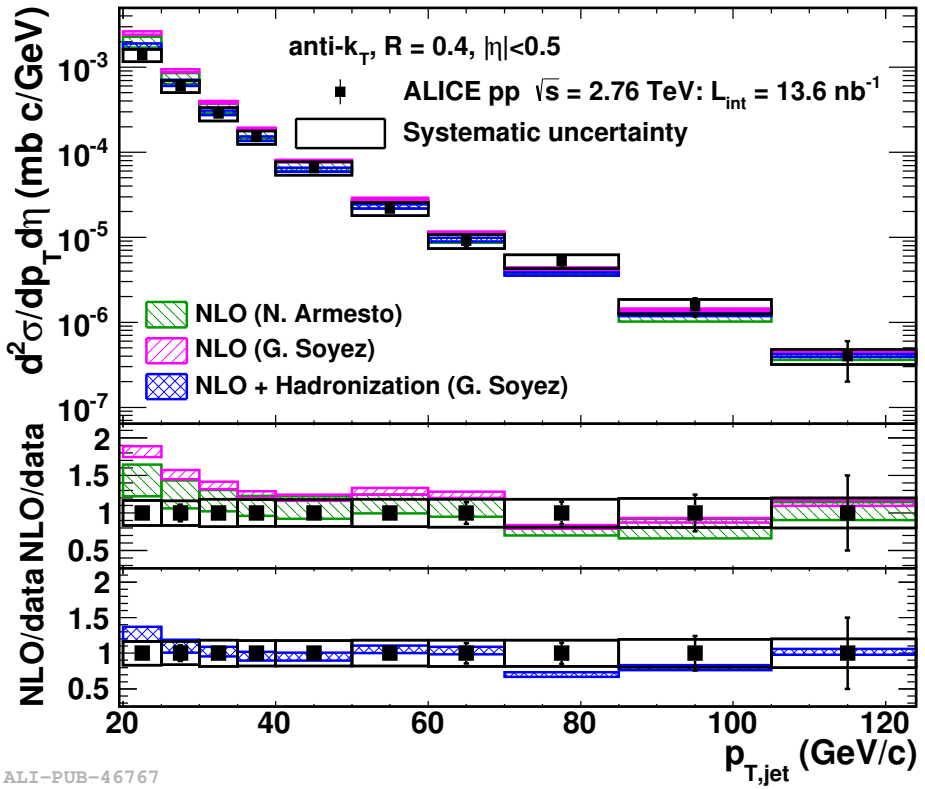
p_{T} density is largest near the jet axis, jets are more collimated at larger $p_{\mathrm{T}}^{\mathrm{jet}}$

Full-jet cross section in p-p collisions @ $\sqrt{s} = 2.76$ TeV

$R = 0.2$



$R = 0.4$

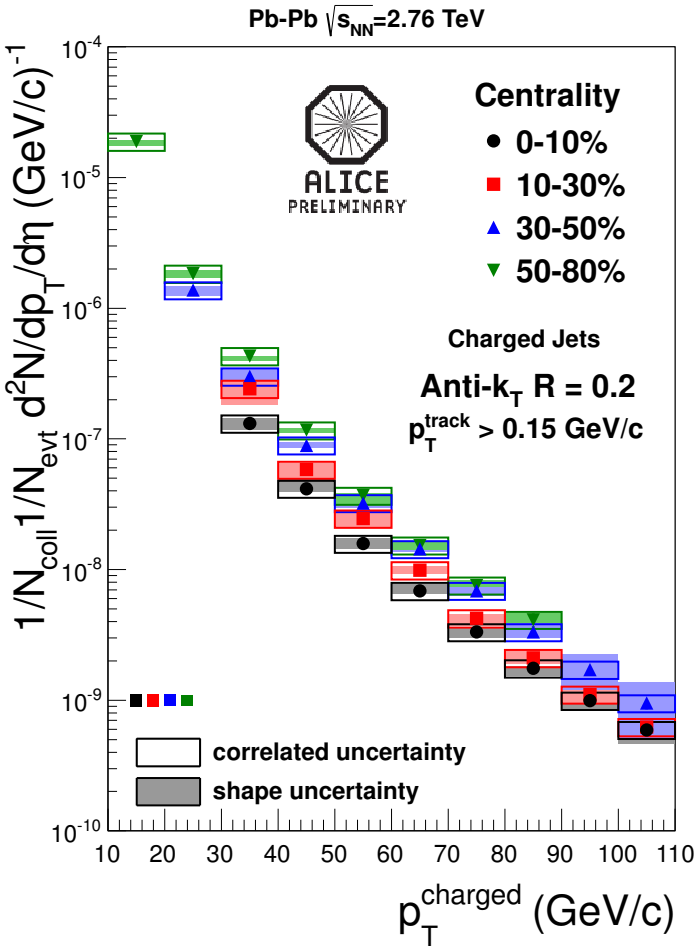


ALICE, Phys. Lett. B **722** (2013) 262-272

hadronisation needed for good agreement of pQCD calculations with data

Inclusive charged-jet spectra in Pb-Pb collisions @ $\sqrt{s_{NN}} = 2.76$ TeV

$R = 0.2$



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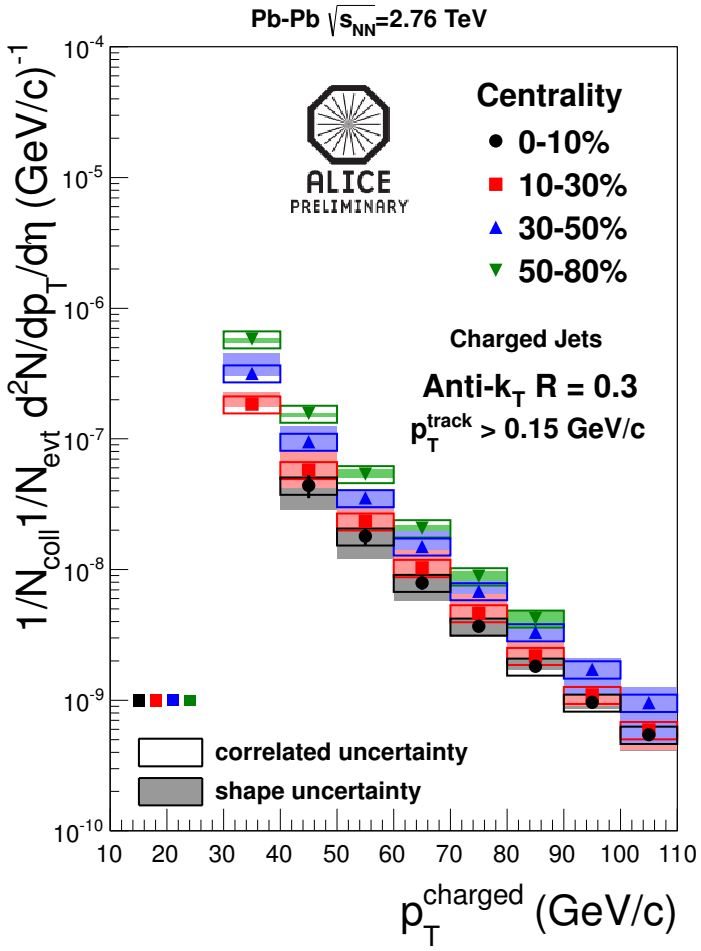
$R = 0.3$



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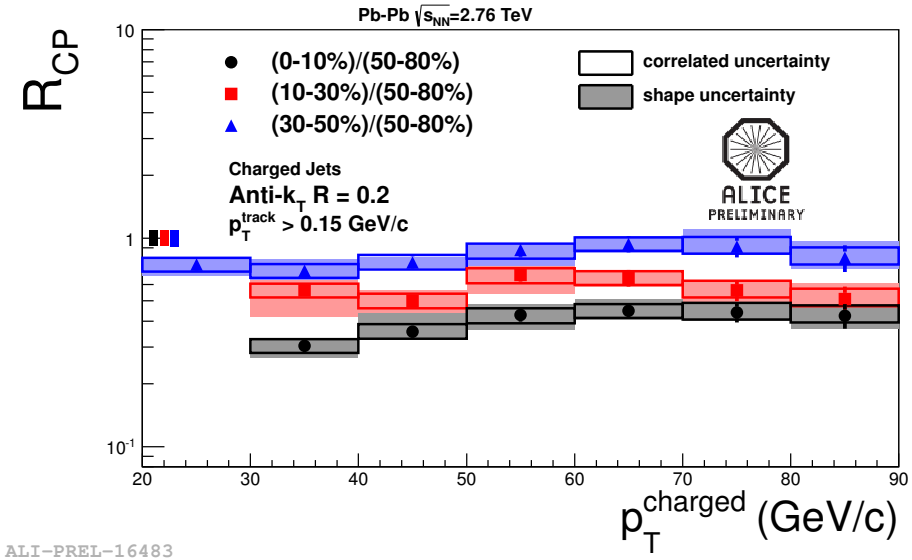
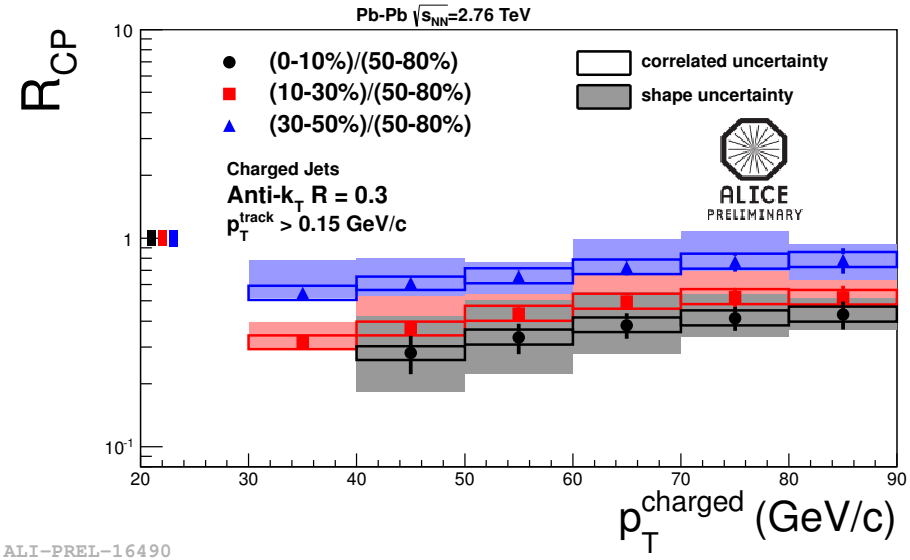
Inclusive charged-jet R_{CP} in Pb-Pb collisions @ $\sqrt{s_{NN}} = 2.76$ TeV

$R = 0.2$



ALI-PREL-16483

$R = 0.3$

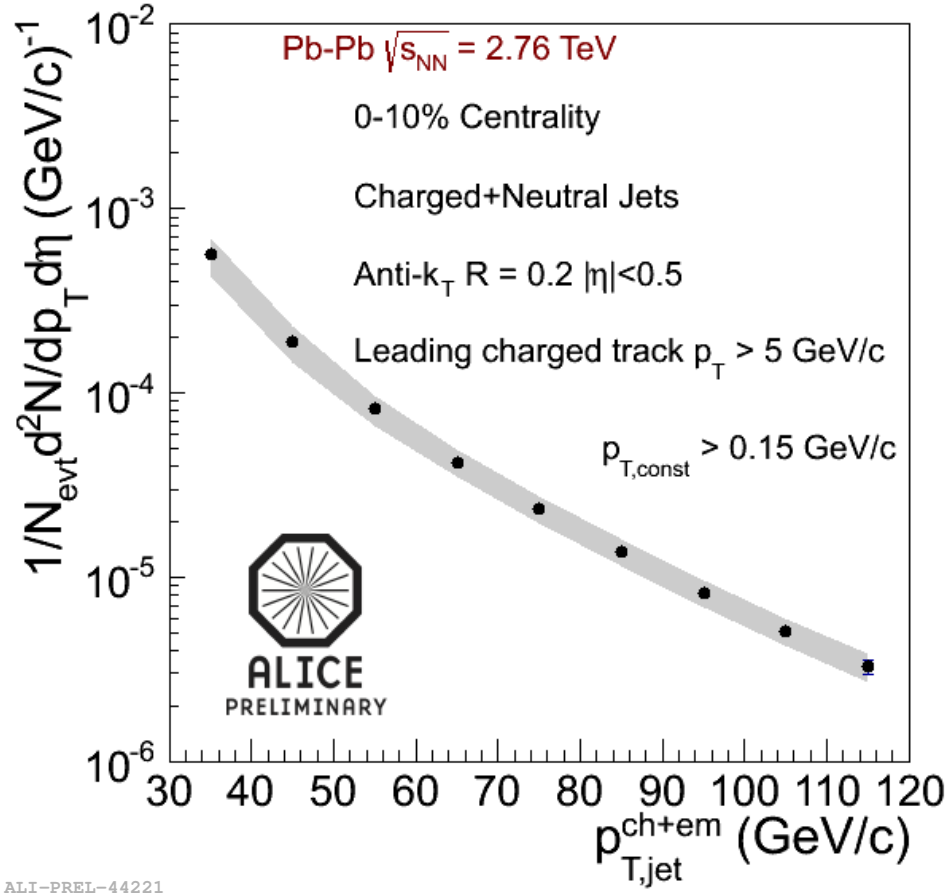


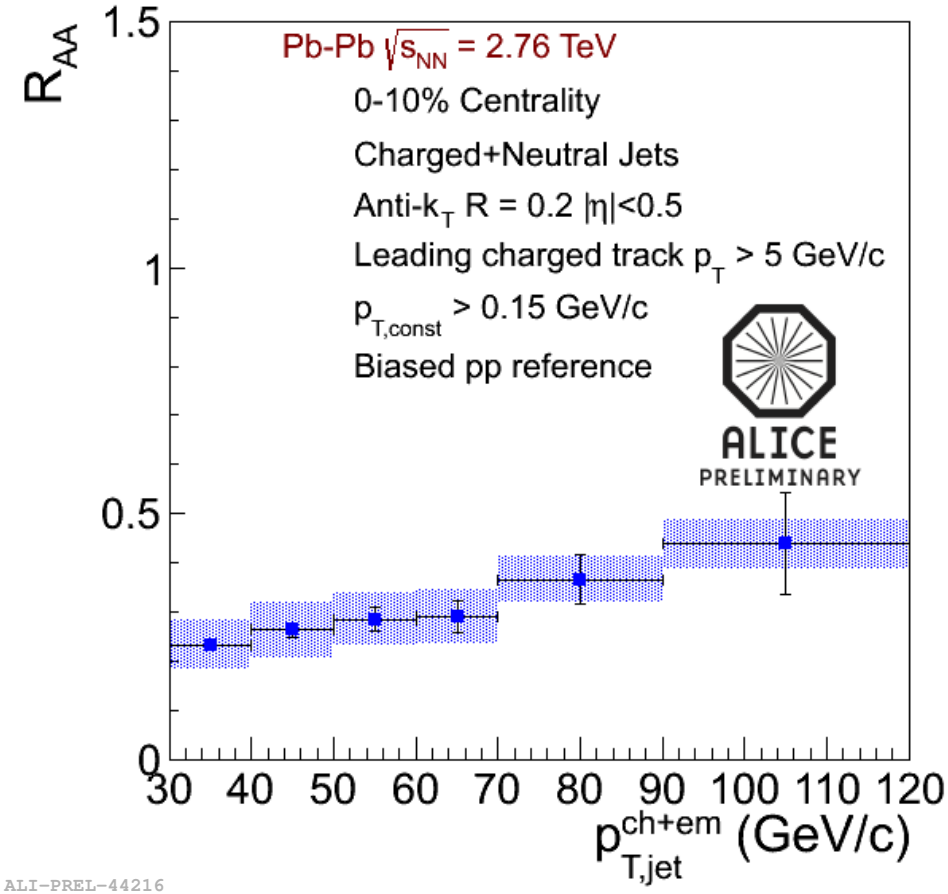
ALI-PREL-16490

strong suppression of jets in central collisions relative to more peripheral collisions

Full-jet spectra and R_{AA} in Pb-Pb collisions @ $\sqrt{s_{NN}} = 2.76$ TeV

Leading-charged-track p_T bias reduces contribution of fake combinatorial jets.
$R = 0.2$, 0–10 %



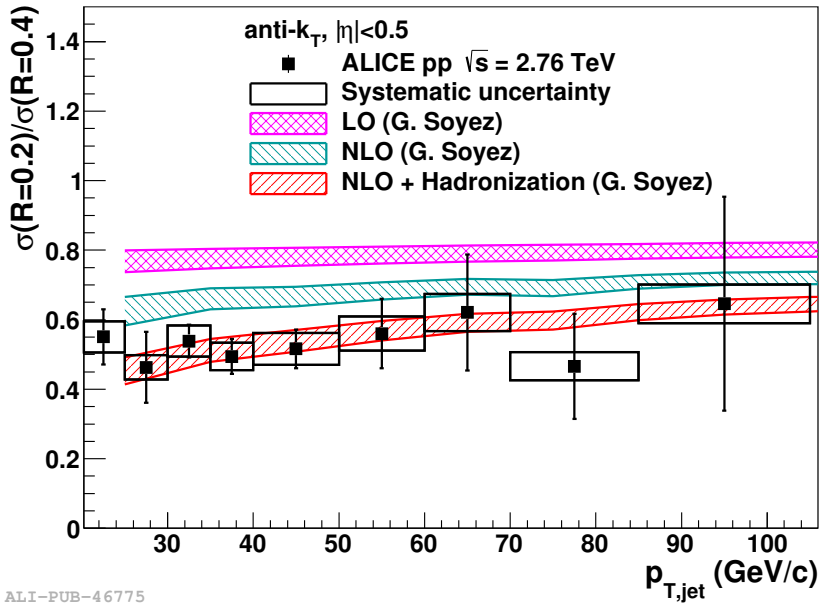


suppression of jets in Pb-Pb central collisions relative to p-p collisions

Jets in Pb-Pb collisions vs p-p @ $\sqrt{s_{NN}} = 2.76$ TeV

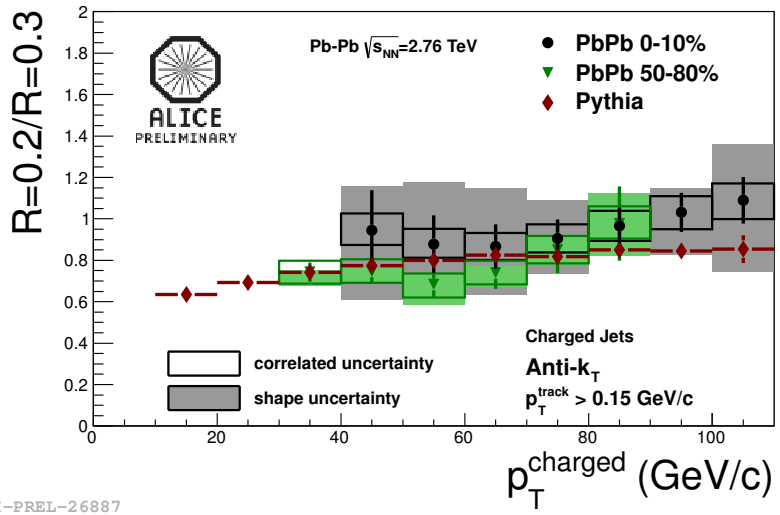
Ratio of cross sections for different radii provides information about transverse structure of jets.

full jets in p-p, 0.2/0.4



good agreement with the "NLO + hadronisation" calculation

charged jets in Pb-Pb, 0.2/0.3



consistent with vacuum jets within errors

Summary and outlook

- Results of measurements of properties of charged and full jets in Pb-Pb and p-p collisions with the ALICE detector enable to acquire a more detailed insight into properties of hot and dense strongly interacting matter.
- Other analyses are in progress
  - spectra of recoil jets
  - jets in p-Pb collisions
  - identified particles in jets
  - ...
- Combination of particle-identification performance of ALICE with the jet measurement may bring unique results that will improve our understanding of QCD.

Thank you for your attention.